CERC-BEE Task 8-2

Energy Quota Setting and Cap and Trade Schemes for Chinese Commercial Buildings: A Primer for Program Creation

A Study Conducted for the US-China Clean Energy Research Center, the Chinese Ministry of Housing Urban and Rural Development (MOHURD) and the United States Department of Energy (US DOE)

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Foreword

Task 8 of the U.S.-China Clean Energy Research Center's Building Energy Efficiency Project (CERC-BEE) calls for a review and comparison of building energy efficiency (BEE)- related policies in the United States and China. As defined in CERC-BEE's joint research plan between the U.S. and China, Task 8 includes three topics:

- Task 8-1. Comparing U.S. and Chinese building labeling and rating systems;
- Task 8-2. Researching into methodologies for setting building energy consumption quotas and carbon trading schemes; and
- Task 8-3. Examining U.S. and Chinese policies on building energy efficiency (BEE), renewable energy use in buildings and green buildings.

This report summarizes one of two studies issued under the auspices of Task 8-2. The report was prepared by the Natural Resources Defense Council (NRDC) and is focused on U.S. experiences with and suggestions on building baseline and energy quota settings, and international best practices on energy cap and trade schemes. A separate study conducted by the NRDC's Chinese counterpart, the Center of Science and Technology of Construction, Ministry of Housing and Urban-Rural Development (MoHURD/CSTC), focuses on methodology and policy studies on building energy quota settings.

This topic was proposed by the China side, which challenged the U.S. side due to its limited real experience in rationing building energy use and carbon trading. We believe China's attention to energy/carbon trading is a welcome sign and should be encouraged. The China side's challenge notwithstanding, our research provides a comprehensive review of all available and relevant international experience, from Tokyo to the EU to California. Our analysis and presentation have fundamentally influenced China's policy making in this area. NRDC has also held a successful workshop with MoHURD, in which we explained that value-based energy quotas face fundamental problems in achieving real net reductions and proposed a better approach.

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Abstract

China has made reducing its energy use a major focus of the current five-year plan. In pursuit of this goal, a 20% energy reduction target for the commercial (or public) building space has been set by the central government. This paper seeks to begin answering two key questions. First, how can an energy use baseline, or cap, be set in the commercial building space and; second, what are the key program elements to consider when designing a cap-and-trade incentive scheme for the sector. After examining the strengths and weaknesses of various approaches to understanding building energy use it became clear that operational, or measured, data would be the best option for setting the cap. It will also be shown that applying a cap-and-trade scheme to the commercial building sector is both possible and an idea with considerable merit. The first point is made by the existence of the Tokyo Cap-and-Trade Program, which includes large commercial buildings in its scheme and has operated since 2010. Lastly, the idea of creating incentive schemes for the commercial space should be pursued for a variety of reasons. These range from the sheer volume of the opportunity, which is huge across building types, to China's desire to curb peak load energy use and finally to encouraging markets for new and or emerging technologies. The paper concludes with a discussion of the most promising practices being implemented in cap-and-trade programs around the world including those that do not specifically address buildings.

Introduction

The Ministry of Housing Urban and Rural Development (MoHURD) is interested in devising a program to cap energy use in commercial (public) buildings. It would also like to investigate international approaches and most promising practices to achieve "beyond code" energy savings – those not mandated by existing codes but achievable with current technologies - with an emphasis on cap-and-trade mechanisms. Additionally, the central government has identified an overall reduction goal of 20% for the sector. The paper addresses the need for incentive schemes to meet that goal, the best way to set a quota, or baseline, in commercial buildings and lastly lessons that can be taken from existing cap-and-trade structures when devising a program for commercial buildings in China.

Incentivizing building owners to surpass code requirements is extremely important in China for a variety of reasons. Opportunities to achieve savings are readily available given that existing codes do not mandate particularly advanced energy efficiency measures. A similar situation persists in the United States where energy savings of at least 14% can be accomplished in all sectors of the commercial market, far more if food sales facilities are not included[i]. Additionally, reducing energy use in commercial buildings can be a key strategy for managing peak load in metropolitan areas as China continues to urbanize. Lastly, decreasing energy use in the commercial sector will also decrease the amount of greenhouse gases (GHGs) being emitted into the atmosphere, causing poor air quality conditions in many parts of the country. Formulating a scheme that will achieve savings has two key concerns: how to set a baseline or quota for current energy use in buildings and how to create a program structure that achieves savings in the most efficient way.

Setting the initial baseline is an extremely important and, at first glance, very complicated task. In general a building's energy data is obtained either by modeling expected usage or actually metering the amount of energy being consumed by mechanical systems. Research indicates that the best way to understand a structure's energy use pattern is to use a combination of both modeled (or asset) ratings and measured (or operational) ratings. A proposed China program should use measured performance baselines as this method will minimize program expense and complexity while also providing specific data for each building to use when calculating required reductions. After this baseline is set the 20% quota can be imposed on top of it. Once a quota setting methodology is agreed upon, officials can then address the question of incentivizing building owners to achieve it.

With the creation of a commercial building sector cap and trade scheme China would be forging new ground. There is currently one similar program operating that includes the largest commercial buildings, the Tokyo Cap and Trade program. While this program has widened the scope of traditional utility focused schemes, it has stopped far short of addressing the entire potential in the commercial market. The envisioned outline of a program in the Chinese market includes broadening the percentage of impacted buildings in order to achieve maximum savings among other elements. Other systems like the European Union's Emission Trading Scheme (EU ETS) or the trading mechanism contained in California's Assembly Bill 32 (AB-32) can be consulted for insights on issues like distributing allowances, creating exchanges for trading and ensuring equity and fairness within those new markets. While there are still many questions for program designers to answer in the formulation of a scheme, it seems clear that on the whole a program for Chinese buildings is an attainable and worthwhile goal.

Codes and Standards: Significant Opportunities Remain

Building energy codes set the minimum requirements for energy-efficient design and construction in new and retrofit commercial buildings. They are a critical component of a robust building standards regime that minimizes waste and maximizes comfort in the built environment. Codes are meant to set an initial goal for the efficacy of a building's envelope, mechanical systems and other equipment in a region. This type of regulation is important however it only sets the low mark – the most basic level of performance acceptable – versus setting an aspirational goal of the lowest possible energy use. Working with property owners to surpass the minimum requirements of most code systems will soften the environmental impact created by a given structure as well as generating additional energy and cost savings over the decades-long, or even centuries-long, life cycle of the building.

Codes in the US: Minimum Standards

There are two primary building energy codes that are generally adopted by states and local jurisdictions to regulate the design and construction of new buildings in the US: the International Energy Conservation Code (IECC), and the American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE) Standard 90.1 Energy Standard for Buildings except Low-Rise Residential Buildings. The IECC addresses all residential and commercial buildings while ASHRAE 90.1 covers commercial buildings, defined as buildings other than single-family dwellings and multi-family buildings three stories or less above grade. It is important to note however that the IECC adopted, by reference, ASHRAE 90.1. This means compliance with ASHRAE 90.1 qualifies as compliance with IECC for commercial buildings[ii]. These codes are a good start on the path to more efficient buildings however they are only as good as the manner in which they are enforced and their overall severity.

Code Enforcement: Infrastructure Exists but Varies

Like the other activities occurring in this space — energy code development through the ICC and ASHRAE processes, adoption of those codes by states and jurisdictions and code-compliant design and construction — enforcement is critical to realizing energy efficient buildings. The responsibility to enforce the building energy code in the US falls upon states or jurisdictions, and the responsibility to comply with the building energy code falls on developers, designers, and contractors. Education and communication between the two regarding energy codes are vital to the effective delivery of both enforcement and compliance. In addition to that, the impact and severity of enforcement measures varies greatly from location to location. Enforcement strategies will vary according to a state or local government’s regulatory authority, resources and manpower and may include review of plans, products, materials and equipment specifications. They also may require tests, certifications or other supporting calculations from firms building new structures or doing significant renovations. Lastly, agencies will inspect a structure during its construction and operating life. All of these activities ensure that buildings meet a basic standard and set the framework for enforcement of other schemes that encourage even better performance.

US Shows Opportunities Great

It has been estimated for the US commercial building sector that, "relative to the business-as-usual baseline for 2020, deploying all net present value positive efficiency improvements in would reduce energy consumption in 2020 by 29 percent, require $125 billion in upfront investment and provide present-value savings of 290 billion in energy costs while avoiding some 360 million tons of GHG emissions per year"[iii]. These numbers do not reflect the potential impact that increased government regulation or incentives may have on the market but merely point to the many opportunities that make economic sense under current conditions. Government incentive schemes can drive early adoption of advanced practices that allow building owners to more easily capture these available savings, decrease existing payback periods and bring even deeper reductions within grasp by charging for externalities inherent in business operations. Lastly, research suggests that significant (more than 20%) energy savings are available in almost all building types and that the size of the building is less significant than many other factors[iv]. It stands to reason that commercial buildings in China, especially modern construction found in major metropolitan areas, should provide a very comparable set of opportunities for efficiency gains.

Intended Outcomes of Beyond Code Programs

Economic Impacts

An incentive scheme for commercial building energy use would create jobs in a variety of ways. Any construction work undertaken to reduce energy use would employ locally sourced labor – positions that are easily filled by a largely unskilled workforce. The product-manufacturing sector may see increased sales as building owners purchase new technologies often made in China. Lastly, the attempt to meet or exceed a building's quota will create demand for a secondary industry of professionals who can help organizations understand their energy use patterns and achieve their reduction goals.

Environmental Impacts

The environmental impacts of an incentive scheme for commercial buildings could be far ranging. It has already been shown that the built environment has great potential for increased efficiency. This opportunity actually increases when discussing the reduction of GHG emissions due to the fact that buildings are not primary but secondary users of energy. All of the energy used in a building is created by a utility and then transported to customers. During the transportation a significant portion of the energy is lost[v]. As a result, energy use reductions at the building level are multiplied when identifying their impact on overall climate change.

Improved Operating Practices

Sophisticated operating practices will be key to achieving savings. Five to twenty percent of annual commercial building utility bills can be saved through low-cost operations and maintenance (O&M) improvements—but only if they are implemented[vi]. Performing the O&M assessment and determining which improvements are most cost-effective is often the most time consuming and costly part of the O&M tune-up process. Once the improvements are selected and prioritized many of them may be implemented very quickly and inexpensively. For example, control strategy or schedule improvements, where the greatest savings often occur, may only take a few hours to implement[vii].

O&M tune-up activities may be the first step in developing a sustainable finance mechanism for the organization. Once an organization funds the initial O&M assessment and tune-up improvements, future energy efficiency work can be funded from the savings generated by the low-cost O&M advances. This kind of sustainable finance mechanism requires monitoring and tracking savings so that the funds can be dedicated to future improvements. All of this would be a byproduct of increased incentives for energy savings in commercial buildings.

Technology Adoption and Commercialization

Efficiency programs for public buildings have impacts far beyond the energy they save.

They drive the creation of markets for new, emerging and innovative technologies. This will provide benefits outside of China's public building and utility sectors and cross over into a host of manufacturing spaces. For instance, China is not only a key manufacturer of traditional lighting technologies but also creates next generation solid-state (LED) light sources as well. An increase in efficiency requirements may benefit those manufacturers by catalyzing incremental demand. This same dynamic can play out over and over again as building owners turn to the market for solutions to their management problems. Distributed generation technologies, advanced HVAC systems and an increased use of building envelope technologies like reflective roofing and low solar gain windows may all be positively impacted due to building owners meeting the new quota requirements.

Energy Efficiency Investment Opportunities

Once penalties and incentives come into force the beyond code program will create more opportunities for energy efficiency investment. Third party investors may begin to see investment in energy efficiency as a lucrative proposition even outside of their own holdings. This could create additional up front capital that flows into the market and unlocks a greater percentage of savings. This issue highlights the fact that incentives and payments should be of an escalating nature. This is because implementing the deepest energy savings possible in a building also comes with the highest price – especially when referring to marginal savings that may require advanced technologies to capture. Investors who focus on the most significant reductions should also be rewarded for their efforts.

Baseline or Quota Setting Methodologies

A building's baseline is comprised of three main energy consumption buckets. The first bucket looks at the purpose of the building, which is also impacted by the level of intensity and quality of services provided within it. The second area to examine is the technical efficiency of the building. This includes both the technologies used in the structure and the design of the structure itself. If the mechanical and passive systems of the building are not optimized internally, and with each other, the structure will not meet its potential performance. Finally, the operation of the building must be examined. This includes retro commissioning on the part of the building management team along with a control system capable of handling what can sometimes be complex usage patterns[viii].

The importance of well thought out baselines to any quota and trading scheme cannot be overstated. The baseline forms the foundation for any market based beyond-code system and, as such, will be fiercely debated as it is being determined and is crucial to the effective implementation of a trading scheme. Generating tacit agreement between building operators, government officials and engineering experts on the best method may not be easy, however it is absolutely essential that all stakeholders understand how the values are generated.

Two Methods for Setting Baselines: Asset and Operational Ratings

In general, two types of rating systems are used when determining a building's baseline: asset ratings, based on data derived from building inspection or drawings and building specifications; and operational ratings, determined using metered data of actual energy consumption in a building. Asset ratings are seen to be most appropriate for new buildings and buildings in which there is frequent change of users, as the rating is independent of users and can be assessed before occupation. An operational rating is more effective for buildings that have less frequent user turnover, and for large and complex buildings. Ratings can be calculated on the basis of on-site energy use, primary energy consumption or related CO2 emissions. Energy scales based on primary energy have the advantage of being a sound and easy basis for the evaluation of cost and CO2 emissions. Rating systems for buildings will often have a different focus for new, existing, residential or non-residential buildings.

Asset Ratings

Asset ratings measure the structure's performance in a way similar to a product efficiency rating. They provide simulated energy use for a building at fixed operating conditions, so fair comparisons can be made from one building to another. The opportunity to compare disparately located buildings of the same type might be an advantage in a municipal or regional scale efficiency trading program. This type of rating system has achieved widespread acceptance as it is in use by the United States Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED) program and by ASHRAE.

Asset ratings do come with some drawbacks however. First and foremost, the cost and complexity of these systems can be burdensome. This is particularly true because running the building simulations effectively requires trained experts who are generally in short supply. It is also more expensive to carry out the task in existing buildings because conditions at the building itself must be inspected, monitored and input into the simulation. Thankfully there are solutions that are being developed for these issues. On the one hand training programs can be created to offer the needed expertise as well as certifying competency at a low cost. Past that, software is being developed that will allow practitioners to easily and quickly calculate asset ratings for buildings with known parameters.

Another issue that is important to consider when addressing the utility of asset ratings is their overall accuracy. Asset ratings often supply an inaccurate assessment of how a building is actually performing sometimes even purposefully. This is because the simulation assumes the building is running at its most energy efficient even though it might not be. This is more of an aspirational rating or a goal to achieve than a measure of exactly how a building is currently or will be operating upon construction. Interestingly, making comparisons with operational ratings or automating inputs using electronic building management systems to reduce human error can often overcome this issue.

Operational Ratings

Operational ratings are those created based on the actual performance of the building. The data is collected using actual metering at the building level and can be adjusted for factors like unseasonable weather. This type of process is simple to understand and use, as it requires very little training or experience to undertake. It serves as a good indicator of year-on-year portfolio improvements as it is an actual record of the amount of energy a building used in any given period of time. It includes the current state of building operation. This means the impact of changes to O+M procedures will be captured in the data that is gathered. Unfortunately, this type of rating can be a misleading indicator in regards to comparative efficiency. There are many other reasons why this type of misrepresentation could occur. From the perspective of a municipality-wide or regional energy-trading scheme, setting baselines solely using operational ratings could result in slower movement towards energy efficiency. This is because buildings will only be forced to consider how they are currently operating, not the most efficient possible way they could be operating. The same would be true when comparing one building against a population of buildings. The single building may be in the 75^{th} percentile in terms of efficiency, but if the entire population is inefficient to begin with, the position is of little significance.

In the US, all energy efficiency mandates for commercial buildings to date require operational ratings. This includes ENERGY STAR Portfolio Manager, which has acted as a key driver of this type of rating system. For the most part, these operational ratings must be recalibrated annually. American building owners tend to favor operational ratings due to their prevalence and relative ease of understanding them. Fortunately, both asset and operational rating systems can act as counterparts to one another in a hybrid scheme.

A Hybrid Solution

Combining asset and operational ratings may reveal a final product that is more valuable than the sum of its parts. This is because the comparison between a building's modeled energy use and its actual energy use can yield indicators of *why* more energy is being used than it should. For instance, predicted low energy use coupled with measured average or high energy use can be an indicator of bad operating procedures, different user needs or that the original specifications of the building were not met during construction, leading to exaggerated low energy use predictions. Using both of these methods in tandem can show operators the untapped potential of their buildings.

On the other hand, comparing rating systems can also have the effect of increasing accountability for simulation inputs. There are many legitimate reasons one school building of the same size and general dimension of another school building could have differing energy use profiles. This has to do with the specifics of each building's passive and mechanical systems as well as the exact location and manner in which the building is located. By using both systems, engineers can begin to identify which inputs are more influential than others in determining energy estimates. Focusing on utilizing these pieces of data when developing simulation models can lead to far more accurate results.

Setting the Baseline for a Commercial Cap and Trade Program

Key Understandings

The strengths and weaknesses of the various approaches to quota setting should be considered with the eventual functionality of the system in mind. China's vast public building sector will force the government to maximize the impact of constrained resources over a broad range of tasks in order to implement any program. This is absolutely vital to keep in mind when determining which type of rating system will be most effective.

It has been shown that both asset and operational rating systems have pros and cons that make them naturally suited for different situations. Additionally, every cap and trade program requires owners and regulators to know exactly how much energy is being used in each targeted building or facility. Operational ratings are the most appropriate choice for setting baselines in a China based scheme because they provide information on actual energy use in a specific structure and are not prohibitively time and resource intensive. This data can be collected over a series of years to control for variations in temperatures, the use of the building or to account for aging systems or other mechanical failures.

Consumption per Unit of Floor Space

The reasons for variation between the Asset Rating and the Operational Rating systems as illustrated above, present a cautionary tale concerning the use of energy intensities (such as kWh per square meter of conditioned floor space) as an energy ration or target. This method has led to problems throughout the world whenever it has been tried. The idea of ranking buildings in terms of energy use per unit of conditioned space is a simple and intuitively appealing one, and thus it has been advocated in many different locales around the world. However, buildings are not that simple and attempts to provide energy budgets per square meter almost always lead to unattractive side effects[ix].

The idea of rating energy performance in kWh/m^2 appears to be a trap that is seemingly intellectually irresistible and has been attempted with little success. The Building Energy Performance Standards Program developed by DOE in the 1970s attempted to utilize this approach however it was never implemented due to political opposition. California was unsuccessful when it attempted to utilize similar performance-based standards for new homes, and commercial buildings in the 1980s. Finally, Shanghai and the Russian Federation tried to use a similar system during the new millennium with similar results. The problem is that the same levels of technologies are consistent with a very wide range of energy per unit of floor area. While some of this variation is due to modeling errors that will be reduced with standardized software, much of it is inherent in the different operations of the building and the technologies used for comfort maintenance[x].

Looking at this issue the other way, it is equally true that the same level of energy per unit of floor area is consistent with a wide range of variation in the level of efficiency investment and technology needed to get there[xi]. Due to this, it seems unfair if the market requires (as a code) substantially different levels of technology or investment for buildings with the same general occupancy category and the same climate. In fact, the market also has no problem with identical technologies leading to different outcomes in terms of kWh/m^2.

Markets are designed to avoid the economic inefficiencies of rationing. An energy use per square meter target amounts to a fixed limit on how much energy use is allowed therefore markets will not respond well to this. This is largely because the way we measure floor space does not account for other factors like the height of the ceiling, the percentage of window to wall area, the direction of the building and many other aspects that directly impact energy use. The market needs a more fine tuned approach to work effectively since each building can only save a percentage of what it is actually using, not what it might be using.

This is because when setting fixed limits, even among like building types, cases will arise where the cost of exceeding the limit for one building may be a lot higher than the cost of beating it (using less energy than the limit) in another building by the same amount. If we allow the building that is over-budget to pay the building that can save the same amount of energy beyond the limit, everyone is better off. Energy use is the same as if both complied with the limit while providing lower costs to the over-budget building owner and a payment to the under-budget owner that exceeded his costs. In a market economy, or in a market-based policy environment such as this simple example of cap-and-trade, the cost of meeting any given energy target is improved across the board[xii]. This building specific approach extends to the world of codes as well where developers have sought to differentiate between types of buildings at a very fine level[xiii].

These differentiations have a significant cost in terms of complexity. In spite of this, code development forums have independently come to the same conclusion: this type of differentiation is an important benefit in the market and makes codes fairer and more acceptable. This thinking can also be applied to the formulation of beyond code incentive programs. Namely, that it is vital to examine the specifics of each building instead of making assumptions across or within building types when setting up schemes.

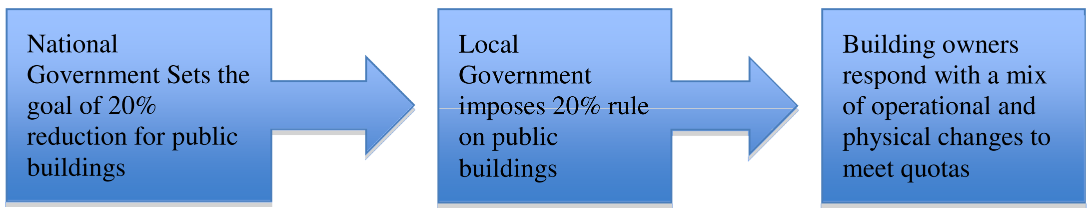
Quota Setting in the Chinese context

The impetus for a beyond code incentive scheme for commercial buildings in China is being driven by the government's desire to lower consumption in those structures by 20% over the next 5 years. In order to achieve this a program must be formulated that adheres to four main principles:

1. The quota must be as fair as possible to various building owners.
2. Required efficiency measurements should be gradually phased in and be recalculated over the life of the program.
3. Determining the quota level for each building should be as streamlined as possible.
4. Adequate monitoring and verification procedures should be thought of and designed to be as practical as possible.

Goals

In determining the relative strengths and weaknesses of different quota setting methods, the overarching goal of a flat 20% reduction in energy used in the public building space must be kept in mind. Of equal importance is the manner in which the quota will be monitored and verified. In keeping with the existing structures, the program will be implemented from the national level to the local level and then, lastly, make its impact at the building level as seen in the flow diagram below.



Since the quota is 20% overall, and it has been shown that savings of up to 20% are attainable in the vast majority of structures, it follows that for each geographic location the program is imposed in, and in each building in those locations, the same percentage reduction would be applied. With a 20% reduction goal as a starting point we can look to answer the question of “off of what” that takes into account the four key facets discussed above.

Progress, not perfection, will be key to imposing a reasonable quota that takes into account the current state of affairs in each building individually and does not put an unfair burden on regulators or building owners. For instance, a hybrid asset/operational program that requires intensive data collection and rigorous building modeling for each structure is exhaustive and may prove too costly to implement on a country or even multiple cities-wide basis. Of those two tasks, collecting energy use data or modeling expected consumption on a building-by-building basis, it seems that the collection task would be most easily passed from government agents to building owners to be carried out, thus making it the lowest resource draw. The reason for this is that building owners, at least hypothetically, are already monitoring their energy bills and therefore have a handle on how much energy their building is using on a monthly and (or) yearly basis. In short, it adequately meets the demands stated at the beginning of this section.

Fairness to Building Owners

Working from an operational based quota will be as fair as possible to varying building owners. The primary reason for this is that all building owners will have the same percentage reduction to achieve (20%) however that reduction will represent drastically different energy savings. Buildings who use a small amount of energy currently will necessarily have a smaller amount of raw energy use to reduce than those who use more. At the same time, each building owner will need to enact changes that are proportional to their input into the overall energy use profile in the public building sector. This method also helps overcome the problem of missing opportunities for energy reduction throughout the building stock.

The other key point to consider is the fairness of the baseline setting and trading systems themselves. Steps must be taken to ensure no individual or group of players in the market have too much control over credit prices – either by holding a large amount to drive up price or by flooding the market with extra credits to lower it. Additionally, the administration of the program may be fraught with potential for inappropriate behavior. With this in mind, a transparent and regularly monitored process must be devised to set baselines and trade eventual credits.

Gradual Phase-In

A program based on measured building performance can certainly be structured to satisfy the requirement that reductions be gradually phased in and recalculated over time. For instance, a perfectly reasonable ramp-up to meet requirements could be formulated as 2% decrease after the first year, 5% (aggregate) after year two, 9% after year three, 14% after year four and, lastly, fulfilling the 20% reduction that is called for in the 5 year plan in the fifth year. Most buildings will be able to satisfy both the first and second year's reductions through operational and behavioral changes which will give them ample time to work towards longer term projects that may require a higher degree of capital, human resources and organizational management.

In addition to a gradual phase in, the program would also be able to streamline the data collection process. A two phase system could consist of questionnaires being sent to building owners and managers who are required to report their annual energy use (or energy use over smaller intervals). After those numbers are reported, utility personnel should be able to verify the veracity of the data given. This process should not prove particularly arduous as both building owners and utilities must keep track of the amount of energy being consumed in order to charge and pay correctly. Additionally, much of this data collection could be done remotely with only a one-time installment of a meter that could also create a host of other savings opportunities.

Streamlined Quota Setting

The most streamlined way to set the quota for each building would be to apply a flat 20% reduction across the board. Not only is this the simplest way to assign reduction values, it also has the best chance of actually achieving the intended reduction. This is because virtually all commercial buildings have the opportunity to reduce their energy use by 20%[xiv]. This 20% does not equal the same amount of energy in all instances but rather applies the right burden to each building: those that use the most energy will need to reduce consumption the most in raw terms while others using less will have a smaller reduction to make. So, instead of targeting the top 40% greatest energy users and force them to make reductions of greater than 20% the program targets all building owners and provides equity by requiring reductions across the board that are commensurate with a building's current use profile and are technically possible.

Practical Monitoring and Verification

Using a modeled energy consumption approach will prove to be extremely arduous. This is because models still need inputs (data collected from schematics and spec sheets) as well as a trained practitioner in order to be effective and accurate. Even with those things in place, a model can only illuminate issues pertaining to *expected* performance. This modeled energy consumption is often incorrect, sometimes even purposefully so, and allows managers to identify areas where the building could be improved. With this in mind, using measured energy use seems to be the best way to set up monitoring and verification, especially when the opportunity to automate that measurement has presented itself in the form of smart meters and other types of web-based monitoring tools.

There are two key ways measured energy use data may be obtained for use in a quota scheme. First and foremost would be for government officials to demand that building owners report their usage directly, which would then need to be verified by the utility (this could happen in reverse order as well). On the other hand, the government could set up an electronic database that is fed by meters in each building on a constant, daily, weekly, monthly or yearly basis depending on the desires of program administrators. While it would take some time to set up this electronic system, it seems far superior to the human-generated information that may be poorly gathered, delivered late or purposefully misleading. That being said, building owners should (hypothetically) know how much energy they are using as they pay their bills. This information could be used to populate the baseline data points.

The development of monitoring tools is integral to the selection of a measured energy use approach to monitoring and verifying the quota. This is because a system could be created that would automatically monitor, report and compile all the information necessary for building owners and government personnel to implement the program. The technology necessary to achieve this is already commercially available and is not price prohibitive, especially if a building is under construction or about to be retrofitted. This database would allow program implementers the opportunity to watch energy consumption on the aggregate city level all the way down to the building level – information that will prove invaluable in lowering energy use by 20% over the next 5 years.

Trading Scheme Models

There is only one operating cap-and-trade model that currently takes into consideration energy being used in commercial buildings, the Tokyo Cap-and-Trade Program, which will be discussed in this section. In addition, other trading schemes are examined in hopes of discerning some most promising practices and in order to devise a set of key questions to answer when devising a cap-and-trade program for China. The figure below shows the basic set up of any trading scheme where a baseline is set, allowances that include a quota reduction are distributed and then compliance with those allowances is enforced.

Trading for Public Buildings – Tokyo Cap and Trade Program

Tokyo is one of the world's largest metropolitan areas, and the city emits approximately as much carbon-equivalent emissions as Sweden or Norway. It is by far the largest sub-national government emitter in Japan, and as the central hub of business and government activity, has an outsized influence in discussions over national environmental policies. In response to this particular role, in 2007 the Tokyo Metropolitan Government (TMG) introduced an ambitious 10-year climate change strategy. Within this broader climate change strategy was a focus on large commercial buildings, defined as those using the equivalent of 1,500 kiloliters of oil annually. The TMG chose large buildings because they were major and growing emitters (accounting for approximately 40 percent of the city's overall emissions from industrial and commercial sectors), their size and the scale of operations of their owners meant they should have the resources to achieve emissions reduction targets and as concentrated sources of emissions they would be relatively easy to monitor. The TMG identified these large buildings as significant end users of energy that could help develop best practices for downstream emissions reduction strategies, a parallel effort to upstream efforts to produce energy either more efficiently or from renewable sources at the utility level[xv].

The Cap-and-Trade program—the first regional program to target commercial buildings—was built using the key tenets of other similar systems. A hard, mandatory cap replaced voluntary reductions programs that had been running in the city and the scheme created infrastructure for carbon trading, the purchase of carbon offsets and verification of actual building emissions. Key to the development of the program was the information tracking carbon emissions gathered under a previous voluntary program. This gave the TMG a robust set of data from which to set the overall cap on carbon emissions, and to allocate carbon allowances in a fair way that might ensure concrete reductions in carbon emissions and reduce the potential to game the system[xvi].

Within that data set were some pertinent insights on the importance of public buildings to energy use and GHG emissions. CO_2 emissions grew in the commercial and residential sectors between FY1990 and FY2006, increasing 37% and 16%, respectively, for these sectors. CO_2 emissions declined slightly in the transportation sector, and declined sharply, at a rate of 46%, in the industrial sector. The distribution shows that the commercial sector expanded its share from 29% in FY1990 to 37% in FY2006. This sector could boost its share further if current trends continue. Changes since FY2000 indicate that the proportional share has been falling for both the industrial and transportation sectors, while significant growth has been continuing for the commercial and residential sectors[xvii].

Cap-and-trade systems can be notoriously complex in design, and the downstream focus on commercial buildings created particular design challenges for the TMG's program, but also huge opportunities for both reductions in energy consumption and GHG outputs. Large cities in particular make the strongest candidates for building level cap and trade programs as structures occupy the majority of space and represent a large percentage of overall energy use.

Key features of the program's implementation included a reliable baseline to set the cap, quality building-specific data to apportion emissions allowance, aggressive and achievable targets for reductions, manageable systems for verified carbon offsets, an exchange for trading emissions and appropriate penalties for noncompliance. These features are meant to create a system flexible enough to allow for innovation and changing circumstances in following new regulations, but concrete enough to ensure substantial carbon reductions. In practice these translate into[xviii]:

1. A three-year emissions average for large buildings based on previous data collection, to set the baseline and allocate emissions allowances, with a reserve fund of allowances to support the entrance of new construction into the system;

2. An offset program, which companies can use to support up to one-third of their emissions reduction targets. These offsets are limited to domestic projects, including verified offsets in buildings smaller than those covered in the program, renewable energy certificates and credits for energy efficiency improvements in buildings outside Tokyo with the same owner. Companies are allowed to bank excess reductions to smooth out volatility in energy use, but they may not use potential future reductions to justify emissions increases; and

3. Two five-year cycles setting emissions reduction mandates. The first cycle, from 2010 to 2014, requires a 6 % reduction in energy use; the second, from 2015 to 2019, requires a further 17 % reduction in energy use, on the theory that efficiencies in the marketplace and innovations in technology and management practices will accelerate energy efficiency gains. Companies are penalized for noncompliance at the end of each cycle.

With the exception of allowances reserved for new entrants, caps for all five years are allocated in gross to facilities in operation at the time the scheme is launched, free of charge, at the beginning of each compliance period. Allowances for the respective facilities (buildings or factories) are allocated based on past emissions. Base-year emissions are calculated by taking the average of actual emissions of a given facility over the past three years. The allowance volume is calculated by reducing the base-year emissions volume by the quota level. 5 years of allowances are allocated at the beginning of the program[xix].

The Tokyo cap and trade program was only formally put into place in April 2010, and it is far too soon to determine its impact. The most important milestone will be the results of the first five-year cycle at the end of 2014. The first emissions trading on the Japan Climate Exchange occurred in August 2010, with carbon emission tons trading at the price of $142, compared to $20.62 on the European Climate Exchange. The high price was attributed to a lack of liquidity in the market and the relative expense of energy efficiency improvements in Japan, which already operate at a high rate of efficiency[xx].

Non-Building Related Cap-and-Trade Schemes

All cap-and-trade systems establish a cap on annual GHG emissions, identify those entities whose emissions will be regulated and set the rules by which those entities will abide. In most contexts, one allowance is required for each ton of emissions, and allowances are usually freely transferable. Allowances can be initially distributed in the market through free allocation based on some metric or another, or sold through an auction. Many of these programs operate in a similar manner, however, each has its own characteristics that are informative and may be useful for programs addressing the building space.

EU Emissions Trading System

The EU Emissions Trading System (EU ETS) is the cornerstone of the European Union's policy to combat climate change and its key tool for reducing industrial greenhouse gas emissions cost-effectively. Being the first and biggest international scheme for the trading of greenhouse gas emission allowances, the EU ETS covers some 11,000 power stations and industrial plants in 30 countries. Launched in 2005, the EU ETS works on the "cap and trade" principle. This means there is a "cap", or limit, on the total amount of certain greenhouse gases that can be emitted by the factories, power plants and other installations in the system. Within this cap, companies receive emission allowances that they can sell to or buy from one another as needed. The limit on the total number of allowances available ensures that they have a value. At the end of each year, each company must surrender enough allowances to cover all emissions otherwise heavy fines are imposed. If a company reduces its emissions, it can keep the spare allowances to cover its future needs or else sell them to another company that is short of allowances. The flexibility that trading brings ensures that emissions are cut where it costs least to do so. The number of allowances is reduced over time so that total emissions fall. In 2020 emissions will be 21% lower than in 2005[xxi].

The EU ETS now operates in 30 countries (the 27 EU Member States plus Iceland, Liechtenstein and Norway). It covers CO_2 emissions from installations such as power stations, combustion plants, oil refineries and iron and steel works, as well as factories making cement, glass, lime, bricks, ceramics, pulp, paper and board. Nitrous oxide emissions from certain processes are also covered. Between them, the installations currently in the scheme account for almost half of the EU's CO_2 emissions and 40% of its total greenhouse gas emissions. Airlines will join the scheme in 2012. The EU ETS will be further expanded to the petrochemicals, ammonia and aluminum industries and to additional gases in 2013, when the third trading period will start. At the same time, a series of important changes to the way the EU ETS works will come into force in order to strengthen the system[xxii].

The EU ETS, which began in January 2005, consists of two phases. Phase 1 (2005–

2007) was intended to be a trial period to work the bugs out of the system; however, in all respects, it functioned as a mandatory and binding cap-and-trade system. Phase 2 (2008–2012) was set to coincide with the Kyoto commitment period in order to comply with obligations stemming from that treaty. Specifications regarding future phases are worked out between member states over time; however, the program is intended to run indefinitely.

The EU ETS is not an economy-wide cap-and-trade system. Rather, it regulates downstream about 12,000 emissions sources, accounting for half of all EU emissions. Covered sources include iron and steel; cement, glass and ceramics; pulp and paper; electric-power generation and refineries. Transport is not currently included in the system, although the EU has now begun to include air transport. During phase 1 the rules allowed countries to auction an upper limit of 5% of their allowances; only Denmark chose to auction the full 5%, the remainders were allocated for free. In Phase 2, countries are able to auction as much as 10% of the allowances under the program. The ETS comes into force slowly by handing out GHG allowances; however as the program ramps up, allowances will increasingly need to be purchased which will increase program impact[xxiii].

There are several lessons we can draw from the EU experience. These lessons can be placed in context by considering three features of a cap-and-trade system that are important when evaluating its policy effectiveness[xxiv]:

1. Cap-and-trade systems establish a new class of asset —the emissions allowance. These assets will have immediate value once the system is established; therefore, initial allocation of allowances is an allocation of wealth.

2. Cap-and-trade emissions reduction policies impose a cost on society and, once the initial allocation is made, the market, not government policy, will determine the distribution of that cost.

3. The spot price is a visible signal regarding the current cost of GHG reductions, while the future price reflects expectations regarding future cost. It also takes into account expectations regarding government policy decisions and

the future price of abatement.

There are many lessons to be learned from the EU experience that would apply to anyone attempting to build a market intended to ration scarce resources. First and foremost, the performance of a cap-and-trade market hinges on accurate monitoring, reporting and enforcement. At the outset of the EU ETS in Phase 1, many nations lacked reliable data-reporting systems, which in part contributed to extraordinary price volatility. The lesson that can be drawn is that inclusion of sectors and additional sources of GHG emissions should be preceded by the development of strong monitoring and accounting systems. Additionally, the ability of government to distribute the economic burden a cap-and-trade system will impose on the economy is greatest during the allowance allocation stage. And importantly, the manner in which permits are allocated can alter economic incentives leading to a variety of unintended consequences. In summary, governments must think very carefully about allocation and keep the allotment rules as simple and transparent as possible.

Trading schemes create allowances, which are assets that can have significant value. Allowances that have fixed lives, like those of Phase 1, must have asset values that go to zero at their terminal points. This raises difficult issues of asset management for those required to hold allowances. This means that nations implementing these types of schemes must develop effective banking rules, or at least short-term overlapping rules from one phase to the next. Additionally, near-term investments in technology needed to radically lower GHG emissions are often confined to the energy sector, where these investments tend to be large and long-lived. This dynamic also happens to make sense in terms of buildings, as many of the best energy saving conservation measures require significant capital to implement and long payback periods to realize positive cash flow. Allowance prices are intended to incentivize these large investments and must have as little political uncertainty as possible. The lesson is obvious: governments need to be as clear as possible about emissions-reduction targets; the commitment periods need to be as long as feasible (certainly longer than current Kyoto periods) and allowance banking is a requirement in order to minimize risk to the new market[xxv].

California AB-32: Cap and Trade Program

The Global Warming Solutions Act of 2006, commonly referred to as AB-32, is a landmark piece of legislation aimed at curbing the release of harmful greenhouse gases, particularly CO_2, into the atmosphere. The bill has many facets including the establishment of a GHG cap, reporting mechanisms for major emitters and the creation of an environmental justice advisory board. Most importantly, AB-32 made arrangements for the implementation of a cap-and-trade mechanism to encourage market based CO_2 reductions. The program is administered by the California Air Resources Board (ARB) and is aimed at reducing GHG levels by targeting key emitters like utilities and industrial facilities. The market comes into force in 2013 and expands in 2015 to include distributors of transportation, natural gas and other fuels. While the program does not focus specifically on the buildings sector, it provides a good roadmap for the establishment of a new market mechanism intended to limit resource use.

The market mechanism set up in AB-32 will initially give allowances out for free to various polluters. These allowances will represent 90% of what the business is expected to pollute. The other 10% has to either be made up for with purchased allowances, offsets or an actual reduction in the carbon intensity of a company's operations. As the program develops it is intended that all allowances will have to be purchased as opposed to the "free" 90% that will be given out at the beginning. Forcing companies to purchase allowances for each unit of pollution they create will monetize the cost of their actions in a much more severe way than the initial free allowance structure. This overarching structure for individual firms will occur under a steadily declining cap that will be set in 2013 at about 2% below the emissions level forecast for 2012. It then declines about 2% in 2014 and 3% annually from 2015 to 2020. This overarching cap will ensure that, despite expected fluctuation in reductions from company to company, reductions will be achieved at the state level[xxvi].

AB-32 will initially place caps, or quotas, on 350 of California's biggest GHG emitters. The first tranche of organizations entering the program will be entirely comprised of utility and industrial sector actors[xxvii]. Three practical issues supported the selection of this group of entities: they are generally the largest emitters of GHGs, they are a fairly discrete group of actors and their GHG emissions are indirectly passed through to end-users and product consumers. The first and second points meant that the state could make a large impact by focusing on the more easily manageable task of regulating a discrete group of actors. This was enticing to regulators from an implementation standpoint and to politicians on the basis of not impacting everyday citizens with more rules or requirements. The program is still able to reach individual consumers when they purchase energy or goods since the cost of "decarbonizing" the production of those items gets included in their price.

The focus of the ARB cap-and-trade scheme is not units of energy, as is envisioned in the China program, but rather units of GHG emissions. This means that a carbon accounting system has to be put in place that both examines overall energy use and related emissions, but also indirect emissions from activities associated with corporate activities. The result is a far more complex and arduous accounting scheme than what would be necessary for a program focused on the building sector. If a building sector program decided to focus on GHGs it could be done easily by applying a carbon intensity multiplier to the grid-based electricity in different locations. California has chosen to go about their program in this way because it ties in with broader goals that are GHG focused and programs aimed at reducing emissions in other ways.

The real purpose of the trading market in this program is to contain costs associated with "greening" the economy. Trading allowances provides impacted companies opportunities to cost effectively reduce their emissions and to monetize those savings. This in turn reduces the return on investment of GHG mitigation strategies and allows firms to engage in even more activities aimed at reducing their impact. Trading also allows those with difficult to implement or expensive options for reducing GHG emissions the ability to minimize the cost of compliance. The program also allows firms to bank allowances that are unused, which guards against shortages or price swings[xxviii]. The program will hold a small percentage of allowances in strategic reserve as a cost control measure as well. One way that companies can reduce the cost of compliance is through the purchase of offsets, however, the program also makes arrangements to regulate the use of this method.

The cap-and-trade system allows for up to 8% of a facility's compliance obligation to be met using offsets. As currently constituted, the program requires that all emission-reduction projects are located in the United States. Additionally, offset programs are restricted to four main areas: forestry, urban forestry, dairy digesters and destruction of ozone-depleting substances[xxix]. In order to prevent fraud, all offsets must be independently verified and registered with the ARB. Lastly, the ARB has begun to formulate provisions to credit offsets registered with entities outside of ARB's purview and to include international programs. The overall lesson learned here is that offsets can form a valuable element of a carbon mitigation strategy, but should not form the bulk of that strategy; they also must be monitored closely to ensure real reductions are being achieved.

The strengths of this type of program are myriad. First and foremost, the idea to "pass through" impacts by targeting utilities and large industrial facilities was wise on a variety of fronts. This choice greatly reduced the number of actors who will be engaged by the program (and who will use the market), which will significantly reduce potential transaction costs for the market as a whole. Additionally, average citizens do not have to be informed about or take time to participate in the carbon market to feel its impacts. They will be signaled by the market to use fewer resources due to the increased price of products and energy. The program also ensures the most cost effective reductions by allowing those who can reduce their emissions at the lowest price to sell those credits to other organizations who may not be able to achieve reductions so easily.

The program is not without its negative attributes. Reporting of GHG emissions is a costly and time-consuming process despite the fact that there are not a large number of actors being impacted. Additionally, the monitoring and verification process for a program such as this can be extremely arduous. The state must be able to independently verify the GHG output of various utilities and manufacturers on a tight budget, thus with limited resources to put towards the task. Additionally, there are concerns about its impact on the economy of California, stemming from the increased cost burden placed on large companies and indirectly onto consumers. Lastly, setting the quota, or carbon cap, for this program was extremely challenging and fraught with political pitfalls. This is in direct contrast to the proposed method for Chinese public buildings that would use measured energy consumption to set the baseline, not modeled energy or GHGs.

Tradable Energy Quotas

Tradable energy quotas (TEQs) were originally conceived of in the mid-1990s as a response to the climate crisis and worries about peak oil. Despite its potential, the idea never got much publicity nor gained traction in political circles. As the European Union began to devise and implement its Emissions Trading Scheme (ETS), national governments began looking for ways to augment the impact of the ETS in their countries. With that in mind, the UK government unearthed the tradable energy quota scheme as a response to both climate change and the depletion of fossil fuels. They argued that any framework designed to address either side of the environmental/energy problem must deliver in two ways: it must achieve a steep, but managed, reduction in the use of fossil fuels and it must forestall fuel poverty by guaranteeing fair entitlements to the energy that is available at any given time. TEQs were designed in the hopes of helping individuals play a more active and engaged role in answering these questions. They are pertinent to the discussion here because they are intended to address a much larger group of individuals than the cap-and-trade programs that have been previously discussed. This may yield some interesting insights regarding an intended buildings program that will impact thousands of individual organizations and structures.

The All Party Parliamentary Group on Peak Oil & The Lean Economy has identified that the lack of frameworks in place to help ordinary people take control of their energy use and carbon output as a key barrier to decreasing both. The idea is that "if citizens were (a) invited to participate in working out for themselves how to live within a steeply-declining carbon budget, and (b) given a guarantee of fair and equal access to scarce energy, climate and fuel policy alike would move into the real world where deep reductions in fossil- fuel dependency would become realistic"[xxx]. This "real world" under discussion is one in which the consequences of energy use, as seen in the decline of finite fossil resources and carbon emissions, are then factored into a person's lifestyle *economically,* not just because he or she is concerned about the climate, resulting in significant energy use reductions. TEQs bring the negative externalities associated with energy use to the forefront of the consumer's mind, which in theory would tip the behavioral balance towards reduced energy use.

The TEQs are anchored to a baseline, the national Carbon Budget, which is set in the UK by the Committee on Climate Change. The Budget states the volume of carbon emissions that will be permitted each year in total and on a per capita basis. The TEQs system then shares out this quantity, by issuing units of carbon to individuals and into a specially formulated market. On the first day of the scheme, one year's supply is issued; it is then topped-up each week, so that there is always a rolling year's supply of units in participants' accounts. Account balances are maintained and monitored by the UK government. Part of the initial issue of credits is an unconditional and equal entitlement to all adults, issued directly into their TEQs accounts (around 40% of the units are issued in this way, in line with the proportion of UK emissions that come from individuals and households)[xxxi]. This part of the TEQs takes care of individual access to energy and also provides limits for consumers to think about when deciding how to spend their energy budget.

The remaining carbon credits are sold by tender as part of a weekly auction to industrial and other types of commercial entities. This weekly auction did not require a great amount of capital or resources as something similar already takes place for the sale of UK Treasury Bills and Government debt. Other countries looking to employ a similar type of scheme may have to build their own auction or clearinghouse capability, which could considerably increase the amount of work required to initiate a TEQ scheme. The auction works by allowing banks and brokers to obtain a supply of units on instructions from investors, and distribute them to non-household energy-users in the economy, to industry and services of all kinds, and to the government itself. By charging for carbon and energy use, the auction provides revenue that the Government uses to facilitate the process of reducing dependence on fossil fuels[xxxii]. When fuel or electrical energy is purchased, buyers pay for it using money, but must also surrender units corresponding to the carbon content of their purchase. The units are electronic so that individuals who use less than their allotment of units can sell the surplus easily, while those who require more can buy them on the market.

TEQs possess many useful attributes for the fight against climate change and fuel scarcity. First and foremost, the program basically guarantees a reduction in the amount of energy being used. This is because the quantity of fuel is determined by the Budget and the price for units adjusts around it. Price in the TEQs model is the free variable—it is the expansion joint that adjusts to circumstances while the actual carbon/energy budget remains static (in line with steadily decreasing issuance of credits). Additionally, the process for awarding energy certificates ensures equity as all individuals are granted the same amount of credits. Putting the consumer in control of his or her own usage is also a strength of the program as it allows people to plan ahead based on their consumption and future allotments[xxxiii]. The impact on individuals' usage can be improved by government intervention and assistance that is funded through the commercial sector purchases of TEQs. TEQs also present advantages over the ETS system as they deal with the first order problem of energy scarcity directly instead of addressing energy use through carbon metrics. TEQs essentially add another charge to household energy purchases – a methodology much more easily understood by regular citizens in the UK – instead of a tax on carbon. Lastly, the program will increase community commitment to the climate crisis, which will create "pull" from the bottom up (citizens initiating changes and government reacting versus the other way around) that will build markets for energy saving technologies and alternative energies. This is due to the fact that solutions for using less energy will not be mandated by government, but will be left to the general populous to decide best or most promising practices for energy use reduction.

TRADING BEST PRACTICES AND RECOMMENDATIONS

Target Facilities

National and regional cap and trade programs usually target a limited number of utility scale power producers and large industrial facilities. This focus makes sense because these entities are physically creating the pollutants that actors in many other sectors, notably buildings, are secondarily responsible for by using products like electricity and metals. Additionally, utilities and industrial facilities tend to be larger in order to benefit from economies of scale during production. This underscores the importance of impacting sizeable emitters as it allows regulators to influence the majority of the market. In Tokyo, the program scope was increased to include a broader range of polluters within city limits – including the largest commercial buildings. This decision reflects Tokyo's desire to continue focusing solely on the largest contributors to climate change. In the context of a municipal program, focused solely on commercial buildings and including smaller facilities, this deserves further examination.

For a building-focused cap and trade program, a broader definition of target facilities is both possible and necessary to achieve overall reductions. It has been noted that almost all building types have the opportunity to achieve 20% energy savings. This is different than at the utility or industrial manufacturing level as smaller facilities do not have the advantage of economies of scale and are often physically unable to achieve the same percentage reductions possible at larger operations. Additionally, the building space has so many actors in it that targeting only those using the most energy may not be able to achieve the desired sector-wide reduction of the scale. The first reason for this is that high energy consuming buildings may have a legitimate reason for their use pattern, like the existence of a large amount of medical equipment on site, and are not able to reduce their consumption enough to compensate for the whole sector. Secondly, even if the largest buildings are able to achieve significant reductions, they may not be responsible for a large enough percentage of total commercial use to achieve reduction goals. The bottom line is that increased efficiency is possible in almost all commercial buildings and only a broad approach to the sector will accomplish the aggregate reduction the government hopes to achieve.

Allowances

The handing out of allowances determines the initial impact of the program, in the sense that it begins the process of monetizing the act of pollution. As discussed above, programs use a broad range of methods for allocating pollution allowances. On one hand, you have programs like the ETS which hands out the vast majority of allowances (at least to start) while others like the TEQs scheme require actors to begin purchasing the majority of credits in the beginning. When devising a program for China, regulators must consider how forceful they want the program to be early on, what type of allowances will be held in reserve to deal with unforeseen circumstances in the market and whether any special allocations will be made for certain building types or owners. The program should look to ask building owners to purchase allocations as soon as possible in order to begin having significant impacts on energy consumption.

Banking

The decision to allow organizations to "bank" or save their unused allowances from year to year is an interesting one. On one hand, it seems counterintuitive to allow an entity to sell an energy reduction from a previous year, however on the other hand, this type of mechanism may be necessary for flexibility. Banking allowances from year to year will allow building owners who do a particularly good job at meeting their reductions to have ample opportunity to monetize their success by selling them when other organizations have run out of "low hanging fruit" opportunities for efficiency. Without the opportunity to bank allowances, organizations will have less of an incentive to achieve the deepest, longest term savings.

Compliance Period and Phase In

The Compliance periods and phase ins of the cap and trade programs discussed range greatly. Generally speaking, there is a baseline period of one to three years in which the energy cap is established and then a following period of three to five years when the reduction quota is implemented. A similar type of arrangement makes sense for China. Using the operational rating method discussed earlier in the paper, a baseline can be set over the course of three or so years. After establishing a reliable, performance-focused baseline, regulators can institute percentage reductions on all or a majority of buildings that must ramp up to 20% over 5 years. This way the program will allow consumers to adjust gradually to increasingly stringent controls.

Trading Mechanism

As part of the cap and trade program, a mechanism or exchange must be created in order to facilitate the interchange of credits. In China this may come with significant complications, as building owners may not be familiar with this type of approach. One option for the Chinese government would be to set up an entity that would operate as a go-between for owners trying to buy or sell credits. This entity certifies the validity of credits to be sold and ensures that the correct amount of funds is transferred upon agreement. This would be far more preferable than a market in which buyers and sellers must be actually engaged with one another to transfer credits. In this case, the exchange really acts as a “clearinghouse” for all the credits being sold.

Execution Method

There are two primary methods of execution under the program. Emitters can reduce their energy use by updating to highly efficient energy consumption equipment and devices and promoting measures to encourage efficient use of said equipment. The second key execution method is the emissions trading aspect, which will incentivize owners who can surpass their required levels of efficiency to do so by increasing the economic attractiveness of the opportunity.

Ensuring Compliance

The last key piece to the puzzle is compliance. This issue will be decided based upon the needs of regulators. If baseline reduction compliance is the most important facet to the government, then fines should begin with a heavy premium. If incremental volumes of savings (or lack thereof) are the most important to regulators, then a fine structure that grows exponentially would make the most sense. From the perspective of incentivizing savings, applying an exponential penalty or incentive to those who are over and under their limit will yield the greatest result. The deepest energy savings often come with the highest price tag; large energy savings will not be financially attractive without a larger incentive than those needed for lower hanging fruit.

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